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ABSTRACT

Technological innovation in the form of the introduction of a formal information system represents change to the people within the organization. This paper (presented to California Educational Administrators participating in the Executive Information Systems program of Operation PEP--Prepare Educational Planners) is directed to thcse managers who initiate the introduction of a new system and are responsible for the successful assimilation of it into their organization. Such a change presents problems, which if not approached correctly, can negate any anticipated benefits. Problems of organization involve the top management, middle managers and the bottom of the organizational structure. As institutors of a new information system, the top-level managers must be certain that those below them feel and derive benefits as active participants in the system design, development and use. Problems of change and growth encompass: (1) changes in information flow and availability, (2) personnel growth, (3) applications, (4) cost, and (5) new employees. The problems resulting from the consideration of standards versus adaptability when contemplating a new information system must be settled by top management in light of the particular needs of their organization so that it will be flexible and workable. (SG)

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PERSISTENT PROBLEMS IN SYSTEM DEVELOPMENT

J. H. Burrows

June 1970

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This paper has been especially prepared for distribution to the California Educational Administrators participating in the "Executive Information Systems" Unit of Instruction as part of the instructional program of OPERATION PEP (Prepare Educational Planners).

This document has been prepared for public release.

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PREFACE

Under a (1968) contract with the San Mateo County (California) Superintendent of Schools, the Information Systems Division of The MITRE Corporation, in conjunction with the staff of Operation PEP* (Prepare Educational Planners), prepared a three-day Unit of Instruction on Executive Information Systems. The purpose of the course, presented in June 1968, was to support Operation PEP in its efforts to introduce some basic concepts of information systems technology to California Educational Administrators.

The presentations included in the Unit of Instruction were augmented by several reports. Three supplemented the discussions by providing general background material. The remainder, prepared as companion handouts for the individual presentations, contained copies of the visual aids (diagrams) used to emphasize significant concepts.

The present (1970) contract between the San Mateo County Superintendent of Schools and The MITRE Corporation calls for the documentation of the concepts illustrated in those diagrams and for the reissue of the supplementary reports. The objective is to provide, in one package, a complete set of references which can be used by Operation PEP in its over-all instructional program. The contents of the package, which consists of eight reports, are identified in the following list.

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* Operation PEP is funded by a U.S. Office of Education Grant Award under Title III of the Elementary and Secondary Education Act of 1965 (P.L. 89-10).

SUPPLEMENTARY REPORTS

Digital Computer Principles

J. D. Porter

Input-Output Trends

J. Mitchell

Digital Simulation and Modelling

G. B. Hawthorne, Jr.

UNIT OF INSTRUCTION REPORTS

Information System Overview

J. H. Burrows

The State-of-the-Art in Information Handling

J. K. Summers and
J. E. Sullivan

A Framework for the Evolutionary Development of an Executive Information System (in two parts)

J. A. Evans

Persistent Problems in System Development

J. H. Burrows

An Information System for a District School Administrator

S. G. Lewis

Collectively, these reports provide a basic overview of information system technology; individually, they focus on some of the specific aspects associated with the design, development, implementation, and use of information systems.

PERSISTENT PROBLEMS
IN
SYSTEM DEVELOPMENT

A

This paper focuses not so much on the technical aspects of system development as it does on the impact of change. Introduction of a formal information system represents change to people in an organization: change in procedures, authority, accessibility to information, to name a few. If they have not actively participated in establishing the shape of change, their perception of it includes an unnecessary bias. And so this paper is addressed to each of you as a person who has, is or will be participating, at one time or another, in the process of changing your organization and its information system in order to adapt to the changing environment, both internally and externally.

For several years I have been associated with an organization whose major area of endeavor is to assist in bringing about the improvement of our customers' operations by helping them to acquire systems that provide new or more timely

information to actors at all levels of the organization. I chose the term "actors" in order to eliminate some of the confusion inherent in the jargon of modern decision-making and management theory. Also, I wanted to bring out our pragmatic approach, that is, concentrate on providing support to people with an "action" role.

Such people rely on information as a source of support for the actions they take. They know that information must be used to have value, and they are keenly aware of the fact that the mounting volume of reports and publications are overwhelming them. They see information systems as a means of simplifying their problems of collecting, processing, generating and distributing data. But they may not see clearly the implications and dangers of change. It is to these people that this paper is addressed.

EXECUTIVE INFORMATION SYSTEM	PERSISTENT PROBLEMS IN SYSTEMS DEVELOPMENT

CONTENTS

- ORGANIZATION PROBLEMS
- PROBLEMS OF CHANGE AND GROWTH
- STANDARDS VS. ADAPTABILITY

A key variable in setting the environment for the development of a new information system is the original impetus that created the need for change. This impetus usually stems from one of the following:

- New Man in Charge
- New Environment (Competition, Change in Environment, and so forth)
- New Technology and Capability Available
- Desire to Keep Up and to Preserve Image
- New Role for Organization
- New Resource Available
- Desire for Improvement, A Dissatisfaction
- Desire to Lead and to Enhance Image

The list may not be exhaustive but it is clear that, regardless of the source of the impetus, there will be work ahead for the organization — and there will be problems. Some of those problems will be discussed in this report under three headings:

- Organization
- Change and Growth
- Standards vs. Adaptability

EXECUTIVE INFORMATION SYSTEM	PERSISTENT PROBLEMS IN SYSTEMS DEVELOPMENT

ORGANIZATION

PROBLEMS

The first category of problems deals with the impact of change (especially of information system change) on the human components of an organization.

Management Involvement
Top - Authority & Desire
Bottom - Work Contact
Middle - Mediating but Threatened

Let us look at the levels of an organization. Usually the authority to direct change lies at the top, the critical work or service contact of the organization is at the bottom, and the interface between the two levels lies at the middle. The middle level responds to the desires and policies generated by the top, and monitors and controls the output of the lower level.*

Based on personal observations, this leads to the following perceptions. The bottom level sees change as new work which may not contribute to its job. Middle management feels threatened by the implications of change: it seldom sees judgement allowed as an integral part of the system, and this is its stock and trade. The anticipation of an apparent loss of ability to exercise judgment in administering justice and providing help to the bottom (responding to personalities and vagaries of the environment) increases its preoccupation with presenting the appearance of order and control to the top.

*The organizational-level relationships are also discussed in another document in this series (see Preface): J. H. Burrows, "Information System Overview."

Top
Can Start First
Can Demand More
Can Overlook Additional Work

Top management, because of its position, can impose more demands and thus bias the system design toward its needs. This same authority also provides this level with an edge in starting first: that is, the system is designed from the top down.

One of the important considerations often overlooked by top management is the full impact of change, that is, the introduction of a new system, on the workload of the lower (bottom) level. Demands generated by the top, for example, a requirement for additional and more frequent reports, are translated into additional cost at the bottom. This cost, especially in organizations that lack the discipline of a profit/cost center operation, is liable to be underestimated or not even considered since reporting as desired is both expected and accepted. Most bureaucracies, most public services, and a few other organizations operate in this mode because their accounting systems do not make the increase in expense obvious in both size and cause.

Middle

May Not Operate
In Common Manner
In Common Environment
To Common Subgoals
Worries About Loss of Position

The middle managers have difficulty because they may not operate in comparable environments or in a common manner to achieve common subgoals. Yet they receive common direction. They also worry about loss of position, collapse of the line chain, about being circumvented by leaders who do not have their local perspective and judgment. Thus they prefer reports that clearly call for little higher-level action.

This trait is common to most management levels; each wishes the system to help it do its job first and to assist it in asking for help rather than prematurely triggering higher-level action.

Bottom

Can Only See Additional Work
Will Resist Incomplete Evaluation
Determines Quality of Output
Worries About Replacement

At the bottom the perspective is the blackest. Most of the data collection and reporting load falls at this level. If the clear, even though unstated, goal of a reporting system is to be evaluative and possibly punitive, the clamor at the bottom level will be for justice, that is, expanding the system to include aspects believed pertinent for complete evaluation. Failing that, it must be recalled that this level controls the input and that some place between the measured or reported event or situation and the ultimate report, judgment usually can be inserted, softening the report to the point of ineffectiveness for its intended purposes, both envisaged and yet to come.

This level, in addition, worries about the impact of the evaluation mechanisms. If punitive in nature, this could result in replacement, that is, hiring and firing. Also, there is an underlying fear that increased effectiveness may reduce the need for people with its abilities.

Solution
Understanding of Goals and
Measures at Each Level
Help to Each in Achievement
Care in Phasing Change

The key to resolving the organizational conflicts and traumas that occur before, during, and after change-in this case, introduction of a formal information system-is communications. In the broadest sense, this can imply participative management. At a minimum, it means that each management level must make a concerted effort to explain, in "fair and square" terms, its use of and need for the system to those at lower levels.

Effective communications also requires that the data gathered should be provided as quickly as possible and in sufficient detail to the appropriate users. This is particularly important at the lowest (operational control) level. Since this level usually is responsible for generating reports for upper management, those responsible for the reports should have access to them as soon as they are produced. The implications of what they are contributing to the reporting system should be evident first to those responsible for generating reports — even if this

means equipping them with additional data processing aids (output as well as input devices). Without such aids those who prepare the reports for processing cannot access them (and other relevant ones) in time to assess their implications. Too often the data is massaged at higher levels and the final products distributed only at those levels with the result that a thunderbolt then descends the hierarchy onto an unsuspecting but sincere employee or group of employees whose inability to access the products in time prevents them from determining that they even have a problem, much less a solution.

The level of detail in the data should provide each employee with help: that is, an understanding of the problem and sufficient context for structuring alternative corrective or adaptive changes. This means that, contrary to the expectations of the man at the top, an information system supporting operations, as distinct from planning, must be implemented first at the bottom and help there before adequate data is made available in a timely fashion to the higher levels of management. Thus it goes almost without saying that any change requires phasing in terms of schedule and impact. It is better to consider and plan this phasing than to just let it happen.

It is important and can affect the perception of change by the various actors. Since this can affect their attitudes, it can spell the difference between acceptance or rejection, being useful or a burden, or, ultimately, successful or failing.

The system that provides effective communications in the form of such reports often negates the necessity of directives (and possibly punitive solutions) from a higher management level. The latter can easily happen, especially when work is viewed as the ultimate test and boss-worker relations as a "for real" extension of the traditional student-teacher role, with one performing and the other grading. The aim should be to get "trouble-awareness" embedded at the lowest level that can take action. Systems thus should be addressed to trouble-avoidance, or early detection and correction, rather than to evaluation and punitive solutions: Help rather than Direction.

Problems of Change
Personnel Growth
Applications
Cost
New Actors

The problems of accepting change thus far have been articulated in terms of human components as referred to organizational levels. The following discussion will focus on some other aspects of change, especially change of information flow and availability.

Personnel Growth Environment
Extension of "Span of Control"
Special Staff vs. Developing Lower Levels
New Functions at Higher Level
Interactive Experience

Many managers believe that introduction of a formal information system is synonmous with "tightening the reins" implying loss of control for the middle and, simultaneously, increased span of control at the top. While this may be true, it is seldom the overriding reason for formalizing or changing the information system. In point of fact, information systems frequently are changed to allow delegation of authority to a lower level. Belief in the system and its predictability, that is, its lack of operational uncertainty, allows problems to be handled at lower levels in the organization, and this is the goal of well-constructed information systems for support of operations.

Higher management needs data for monitoring and planning, not for control. It has other jobs.* The man at the top wants to, and does, give away his internally generated problems as fast as he is convinced that the procedures and information flow below him are able to handle the problem and bring about satisfactory performance. Adequate control can replace his involvement.

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*I would like to point out a current management trend in all large endeavors: namely, the growth of special staffs at the corporate level as distinct from promotion of line managers to those staff jobs. In the world of education this would mean that not all planners would be former teachers and principals: some would be former specialists in other aspects of education. I alluded to this in my other paper (see Preface). Much of the planning data for the future orginates outside the operating environment of the organization. This factor, special and new skills, more than the almost concomitant introduction of the new technology in information systems, is changing the growth environment for middle managers.

I am reminded of a consultant friend who complained that a two-month job he had done for the president of a firm had come to naught. He had investigated a persistent problem, presented his analysis and recommendations. He returned a year later and asked the president how he was doing. The president said that he wasn't interested in that persistent problem anymore. Although possibly not flattering to the consultant's ego, in actuality that was the best compliment he could have received on his work, for modifications of his recommendations had been implemented.

In addition to increasing the amount of time available to higher management for handling the more external and intangible aspects of organizational matters, there are other reasons for improving the procedures and tools available to allow a more "now and here" oriented manager to assume increased responsibility. The first is that delegation enriches the position and experience of the middle managers. Too many

such managers are used only as "person" handlers and communication links. The second reason is to avoid just that for your own position. If authority becomes too centralized and the tools are developed for a specific spot, yours, in the organization, it is clear to the man at the next level up that he can take over by learning to apply your tools, thus turning you into a communication link and "person" handler. I don't wish to downgrade "person handlers." This is one, if not the most important, aspect of management, but it requires authority to make adjustments to manage.

I have talked about the information gathered at the top to support planning. I did not mean that complete plans were prepared at the top but that data were gathered, organized, and acted upon, allowing the top to disseminate to lower-level managers predictions of things to come, both internally and externally, if the world develops without their taking action. In addition, guidelines and goals for future operating plans, for example, next year's operating plan and its budget, are disseminated. Typical information might be: (a) foreseen

reactions developing among the workers, for example, the teacher's union, (b) changing pupil distribution by some relevant characteristic expected to start next year and to continue due to some public capital expenditure such as an expressway or some private capital expenditure such as the opening of significant new housing developments; (c) changing expectation of the school board(s) or the populace in terms of output of the system; (d) new federal and state regulations and their impact; (e) fiscal guidance; (f) new programs to be instituted or deficiencies to be alleviated; and (g) availability of new resources or techniques that can change costs or output. Thus two of the older one- and two-step management philosophies, total direction and purpose/dispose relationships, have been or are being replaced with a three-step philosophy: constraints, expectations and trends, and goals coming from the top; proposals or plans coming from below; and final agreement on the operating plan for each subunit being the final step before execution. Actually even the one-, two-step philosophies result in three-step activity; it is just more efficient, leading to faster and more effective convergence, to plan the three-step rather than have it happen to you.

One drawback of using a computer to "solve" a problem may be that it does too good a job, it gives the answer. Many assistant principals who face the tedious yearly problem of a room-teacher-pupil assignments may welcome assistance from the computer but they learn quite a bit about factors such as critical resources, constraints, and loads from working them out manually. A pat solution to the problem from the computer deprives them of the opportunity to renew this familiarity. Some other way must be found to internalize within them the implications of this derived schedule.

One of the new technical aspects of computer assistance addresses this (and other problems) head-on: that is, the support that can be derived from on-line interactive systems.* Such systems can be designed to allow the user to watch the solution develop, guide its development, override or select options, and thus get a "feel" for the environment of the solution. Such techniques have been developed for the military, as many of their planning problems have non-quantitative constraints and measures of "goodness," and they must have a feeling for whether the solution is delicate or stout-hearted and able to, through minor modification, handle minor and some major changes in desired outcome or load (threat). This is another way to allow the new technology to enrich the manager's experience and to expand his ability to handle a broader spectrum of solutions and ultimately problems.

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*These systems are described by J. K. Summers and J. E. Sullivan in "The State of the Art in Information Handling," (see Preface).

New Applications
Add-Ons Without Rethink
New Uses of Old Data
Meaning (Operational vs. Semantic)
New Threat
New Load to Someone

Another source of persistent problems can be identified by considering the content of new applications for the computer or automated portion of the organization's formal information system.

As alluded to in my other paper,* the initial justification most commonly used for introducing computer-based information systems is cost savings. The programs and procedures pertaining to the application areas selected for computer support are designed to minimize the costs of such applications. As the system evolves, there is a tendency to consider that which already exists as sacrosanct and unchangeable, while the appropriate overall design may require changes in procedures and programs for areas already supported. This is to

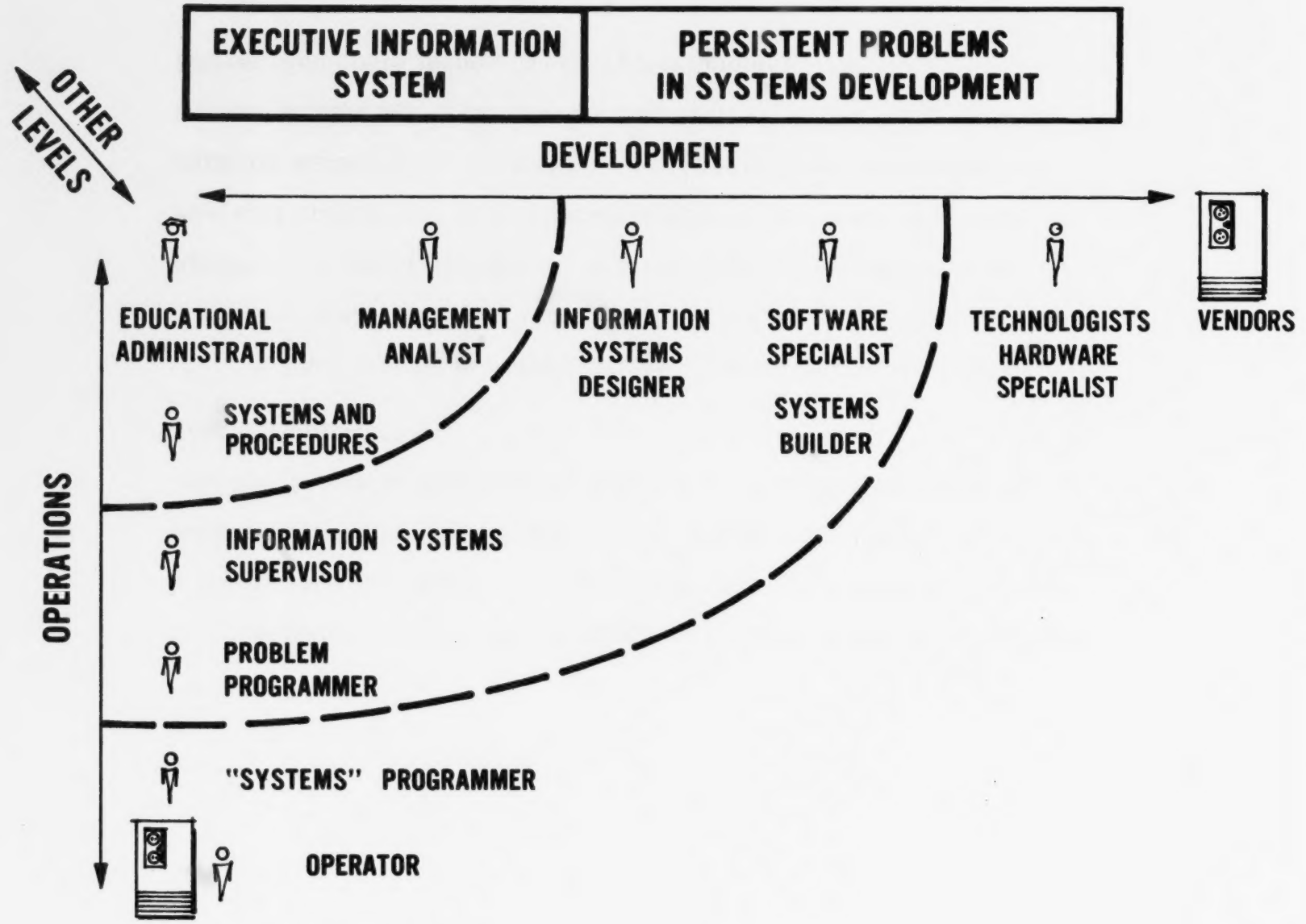
*J. H. Burrows, "Information System Overview," (see Preface).

be expected and can be avoided only partially by extensive pre-planning of growth options when initially starting or when overhauling an already in-being system.

Another persistent but not immediately obvious source of problems with new applications stem from using seemingly factual data collected for one stated purpose for another purpose. This problem is magnified if the data so used has been subjected to the judgmental filter of a person or people. People report not only what they think you want to hear but what they think would be useful (either to you or them) for you to know: that is, the meaning is partially embedded in the use. The filter took into account eh original expected or stated use; it might not be applicable to the new purpose.

Beyond the aspect of meaning, such applications may constitute a threat and thus affect not only morale and organizational cohesiveness but so change the meaning of the data in the mind of the reporter that new incoming data may no longer be useful for the initial and primary application.

A final note on new applications: they create a new load on someone, make sure you know who, and budget for it. Initial applications are frequently studied thoroughly, but additions or new applications are incorporated mainly on the basis of a spare capacity somewhere, for example, computer time, programmers, without thought about the overall distribution of load being created. Information costs money in one way or another.


EXECUTIVE INFORMATION SYSTEM
PERSISTENT PROBLEMS IN SYSTEMS DEVELOPMENT
OTHER LEVELS
DEVELOPMENT
EDUCATIONAL ADMINISTRATION
MANAGEMENT ANALYST
INFORMATION SYSTEMS DESIGNER
SOFTWARE SPECIALIST
TECHNOLOGISTS HARDWARE SPECIALIST
VENDORS
SYSTEMS AND PROCEEDURES
SYSTEMS BUILDER
OPERATIONS
INFORMATION SYSTEMS SUPERVISOR
PROBLEM PROGRAMMER
"SYSTEMS" PROGRAMMER
OPERATOR

Thus far this report has focused on internal problems associated with the introduction of new technology into an organization: problems of organizational form, personal relationships and responsibilities. (I cannot stress enough that significant change is painful, and pain, potential or felt, needs attention or it can divert the entire effort.)

By means of the opposite chart, I now want to introduce you to a new set of people with whom you will have to deal in order to use the new technology but who may not be a part of your organization. You are in the upper left-hand corner; your organization is referenced ("Other Levels") but not shown in detail. You or some of your staff people may occupy positions around the first level, "Educational Administration."

Most of you probably are not familiar with the representations beyond that inner circle. They are the specialists: they have their own jargon and frames of reference which give them unique but different perspectives of your situations and desires. Incidentally, they have their own desires.

If you decide to develop a computer-based information system, you will be interacting with the development crew, shown along the top axis. As you near operational status, you will need the crew identified along the vertical axis. As you proceed, the need for the top group will wane and be reactivated, depending on your desires. The need for the operations specialists probably will continually grow.

These specialists cannot handle the problems I have written about to this point. They can help, but the basic responsibility for facing those problems is yours, and it cannot wholly be delegated.

Development Team
User-Organization Stability
Developer-Operator Mismatches
The "Immovable Object"
"I Can Get it for You Wholesale"

It is clear that you need help in undertaking the analysis that should lead to a significant change in your current information system. Usually such help is provided by a development team.* The preferred approach to structuring this team is to include representatives of the ultimate user as active participants. If this cannot be done, the team must have easy access to the user.

The preferred approach represents the first painful expense to the organization —— freeing talented personnel who are performing valuable services to work on setting current context and requirements for the ultimate improved system. At such times managers may forget that such participation is important to them as well as to the organization and send respected, but slightly superannuated, or young and aggressive, but slightly non-conformist, personnel to represent their interests. Each manager feels that someone will ultimately protect his interest and that his current job is his primary task.

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*The importance of an interdisciplinary development team is discussed by J. A. Evans in "A Framework for the Evolutionary Development of an Executive Information System," (see Preface).

Someone at a high management level in the organization must make clear the price to be paid and make a decision on the level of risk to be taken now to improve the future. Putting one area of management in charge guarantees that he feels responsible but releases other segments from immediate responsibility. Clearly several mechanisms are available to top management, and selecting the mechanism and stating the price begins to set the tenor for the ultimate system.

I have already referred to desires —— yours and those of the development team —— as representative of another source of problems. Extracting needs (requirements) from desires is no easy task. It involves, among other things, a knowledge of your job —— what you are explicitly and implicitly required to do —— and the goals and objectives of your organization.* I have seen systems in which elaborate reports are produced side by side with relatively simple summaries: the former get bound and filed while the latter are in great demand. The desires of a user with political clout were mistaken for needs. Development teams need management guidance in making cost-critical trade-offs. In an area where the costs of producing such reports impinge upon the discretionary funds of the user, such decisions are aided by presenting

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*Goals and objectives are discussed in J. H. Burrows, "Information System Overview," and in J. A. Evans, op. cit. (see Preface).

the estimated bill for services to be rendered. Short of that, management compromises must be made, and such compromises usually are outside the area of responsibility of the development team. Effective and timely mechanisms to accomplish this must be established.

One of the difficulties of computer-assisted systems is the elapsed time from validated requirements to delivered and operating capability. Just as one does not expend energies improving other than the weakest link or expect seven-place accuracy from two-place data, one should similarly avoid the mistake of tailoring any formal part of the information system to a specific organization or incumbent unless stability significantly beyond the development cycle can be predicted.

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It can be expected, from the newness of the technology and the different perspectives of the people, that mismatches in relating jargon (you have yours, too) to goals will occur. Although the technical developer can apparently talk more to the point of "how to," this should not influence the "what to," except through considerations of cost, operation, maintenance and modification, and growth. The user/buyer must take responsibility and authority, refusing to relinquish his birthright to the technical expert. This does not mean that he can impose his desires; he must discipline his requests, define his needs, and weigh the expected benefits against the expected costs.

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Formal change procedures are needed, once implementation is started, and a less than adequate initial implementation (requiring subsequent modification) is by far preferable over a never-delivered, up-to-date design on paper only.

Somewhere every organization has one or more "immovable objects." Max Planck, in the last century, noted that the new physics would be accepted only after the old guard had died. In current military systems, it has been observed that old-timers tend to underuse new tools while younger personnel soon out-perform the more experienced. This points out the need for educating the old-timers and for exercising care in both manning the development team and in managing the review, installation and use of the new information system. Hopefully, old dogs can be taught new tricks.

Just as your organization has its conservative elements, outside technical organizations have their enthusiasts. Frequently, their approach focuses on a set thing which they claim is just what you need. It might be, but usually after the initial promise and low cost estimate it is discovered that your needs are different. Now you are about to embark on an unplanned, piecemeal development, usually without a "feel" for ultimate cost or a management mechanism to keep the development in line with expectation. When faced with an apparently inexpensive proposal, don't jump until you have planned for various outcomes ___ from "no development, just installation and orientation," to "no application available, start from scratch." Then when inexpensive solutions are unsatisfactory, default the contractor, actually or in spirit, and regroup to consider alternatives. Don't just drift.

Cost

Things to Come

Hardware

Analysis

Software

Data Collection

Cost is a fact of life. The problem with cost is the lack of perception of cost or, alternately, the lack of perception of cost trade-off. First, let's consider cost by itself. Almost all who acquire an automated information center realize it contains a computer (this may not be be quite so evident in the future). That piece of hardware is expensive, or at least comparatively so. Thus hardware costs never are overlooked, at least for that hardware acquired for the data processing center. New methods of accessing the computer, for example, teletype machines, introduce new costs —— communications and terminal costs. If an organization provides remote-access capabilities extensively to its staff, the cost of hardware located outside the center may exceed that of the internal hardware. This may be overlooked when initial decisions are made, especially when developing the "I want — I need " list.

The next cost factor relates to analysis and specification of the design of the system. This can be done within the organization, by outsiders, or by both. In any event, it requires

an investment of time —— the time of those who will use the system as well as of those who will contribute to the design, development, acquisition and implementation (the specialists) of the system. For some members of the development team, those who represent the organization, full-time participation is secondary to their major responsibilities. This has been discussed earlier. But it is the organization's staff that is required to accept change, that is, the new information system, and even in an authoritative environment, participative decision making* is the cheapest way to gain acceptance and understanding. The analysis activities that can be identified and costed usually range from one-half to twice the three-year hardware costs.

Software development and maintenance usually is greater than the analysis cost. Here management control and talent are the two requirements for efficient and effective implementation. Numbers are less important than quality. I contend that for some aspects, not management or over-all design, talented and eager high school students (probably on their way to college) will read and think more about the problems of implementation than many so-called

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*For a discussion of management styles, see R. Likert, New Patterns of Management; New York, McGraw-Hill Book Company, Inc., 1961; and R. Likert, The Human Organization: Its Management and Values; McGraw-Hill, 1967.

programmer journeymen. There is a compromise between duller but permanent employees and bright but transient workers. The latter can be used only under good management control, and good documentation (equivalent to blueprints and user and maintenance manuals) of work done clearly is required with transients. In fact, good documentation really is required in any event and is one thing an organization which "does its own" must bear down on to produce. An outside organization expects to deliver documentation (usually as little as can be gotten away away with) as part of the product. Documentation can be as much as one-half the software implementation cost.

Finally, let's consider an expense frequently overlooked: the cost of getting data.* For some jobs, for example, engineering calculations that would be done by hand if a computer were not available, this cost may not grow. However, with the availability of a computer a more extensive job usually is done, entailing collection of more detailed data. For most commercial and/or management jobs, either new data is required (usually in new forms) or the incidence of error must be significantly reduced, for example, no misspellings. These costs can exceed

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*This point is covered by J. H. Burrows, op. cit., and by S. G. Lewis in "An Information System for a District School Administrator," (see Preface).

the sum of all other costs and thus can be the determining factor in regard to cost versus benefits. I have seen a system (not selected as an extreme) where the costs listed for hardware, analysis, software and data collection have a ratio of 5 : 4 : 7 : 70 for a three-year period of operation.

I have spent some ti trying to instill a respect for the sources of cost in a new information system. I would like to reflect on the fact that such costs are inherent in any information system, including the ones in use today. Formalizing the system, centralizing the design, and justifying a new capital item only forces a focus on these costs. This is one of the reasons for the existence of the "folklore" theme in the business. The analysis frequently pays for itself through improvements in the current system, even if a computerized system is not the outcome of the analysis.

Aspects of Standardization
Nature of the Problem
Approaches to Standardization
Current Technical Approaches

Standards have their uses. They save money, reduce implementation time, avoid blind alleys, facilitate introduction of replacement personnel, and make limited expansion of the system easier. On the other hand, they constrain design and development. Standards eliminate some of the desired options. Hardware, for example, has standard interfaces. The capability you may need to perform a critical job may not be compatible with the interfaces. If used, standards may constrain the processing power of your computer. What is theoretically possible may not be practically achievable. The processor selected may do less than what you want it to do in a given time period. This presents the problem of cost versus value trade-off.*

This final section of the paper considers some of the aspects of standardization in order to provide some guidelines for the manager.

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*See J. A. Evans, op. cit. (refer to Preface).

Aspects of Standardization

Hardware
Formatting
Applications Programs
Access to Service
General-Purpose Software

Questions such as "Hasn't this been done before?", "Haven't others faced this problem?", "What can be gleaned from the experience of others?", "What can be standardized?", "Should I accept a standard programming language?", "Which one?", "What does it do for me?", constantly arise during system design and development. Aspects of these questions will be discussed on the remaining pages of this report.

Let's look at some of the areas in which standards or standardization and development cost-sharing might take place.

First, there is hardware. This includes the computer, major secondary storage media (magnetic tapes, disk packs, cards, paper tapes, and so forth) and, if the system provides for remote access, terminal devices (teletypewriters, typewriters, and so forth) are also involved. While the savings in training, maintenance and software are obvious if the types within a system are minimized, taken to the extreme this would imply one type for everyone. Someplace the costs outweigh these benefits.

Second, especially within a loose federation of operating units, there is the agreement on meaning and format of reports. Much of the impetus for this comes from upper management, law, or associations that collect industry-wide data.

Third, there are programs (software). These are always seen as an expensive item in both dollars and elapsed time to initial use. Thus applications programs, available for free through some cooperative organization or at some cost from a broker or developer, appear to be an out. Indeed, these programs, especially those directly available from the manufacturer of the hardware, are used to a significant extent. However, programs are a manifestation of organizational philosophy, management practice, and operational environments. Where these are shared to a large extent, the programs can be shared. One must remember that requirements analysis, the orientation of the organization to the benefits and expectations, and training, operation, and the eventual modification and integration with other parts of the information system, generate costs that must be borne by the buyers of these standard program packages.

Fourth, a new area for standards is appearing on the horizon. It is generated by the advent of computer utilities which provide the user with a means of gaining access to computer power without owning a processor. Equipment (for example, user terminals) and techniques for such time-shared data systems will be standardized. In the future you may be able to access information sources and programs produced by, say, portions of the government when, for

example, you desire detailed population growth predictions, forecasts of economic growth, and other data useful for planning purposes.

Finally, the proliferation of so-called general-purpose software packages has an impact on standards. This software, addressed to file maintenance, report generation and, in some cases, on-line inquiry, can return to the computer user some of the flexibility which seemingly was available in the manual system while still handling the bulk data in an economic fashion. New and unpredicted reports can be generated in a matter of hours with the aid of such packages as compared to days and weeks with some of the more classic approaches. The packages are easier to manage but, given that you can get good classical programmers, they usually run longer on the machine. This is less of a problem these days since second, third and fourth shift costs for the hardware are down significantly —— 10 versus 40 per cent of prime shift costs —— from several years ago.

Approaches to Standardization

Prescribed Formats

Prescribed Applications Programs

Prescribed Hardware and Software

Data Element and Code Definition

The approaches listed above constitute the primary techniques used by the military to reduce the maintenance and training costs of information systems. The first three have been discussed. The fourth, because it is necessary to any data system that carries information throughout any organization, also deserves attention.

Data Definitions: What Is It vs. Coding

Dictionary Approach
Ultimate Use Approach
Collection Approach
Expected Total Use Approach
Need for Environmental Interpretation

Most managers tend to neglect the above aspect of standardization; that is exactly why I am reviewing it. Embedded in this aspect is the quality and acceptance of the information system, and that establishes its importance.

When programmers talk of data definition, most really are speaking of form, not content; of coding, not meaning. Form and coding are standardized by those who initially collect the data and prepare it for processing. This is required in order to use the computer. What I want to discuss is meaning, a problem not unique to computer-based information systems. Again, the people who initially collect and use the data have assigned standard meanings to it —— probably through negotiations. At a later stage —— during documentation, for example —— those meanings often are misconstrued by a new set of actors who may rely on the dictionary's definitions rather than on the implicit definitions implied by the operations of measurement and use.

Most of us are familiar with the dictionary approach to definitions. To most people using the system, however, definitions would speak to the use of the data: Why is it wanted? How is it to be used?

To those at the top, a more pertinent definition would involve the operational description of the data: What measuring instrument and procedure were used to derive the data? Where does it come from? What has been done to it? A trivial example would be knowing the instrument before commenting on the meaning of an I.Q. measurement.

What really is needed is an understanding of the total use of data collected by the system and an understanding that isolated data, while useful, has lost some of the meaning inherently ascribed to it when its context also is available. To know that the Grade 6 reading level at School A is 4.6 and at School B, 7.2, conveys some information. To know that School A is in the ghetto and School B in the suburbs, or vice versa, conveys a new set of meanings. To know, in addition, that last year's Grade 5 reading levels at the two schools were 2.4 and 6.8, respectively, provides still another slant on the data.

Now consider the reaction of the school principal to inferences derived from the initial facts when economic background is not considered in the interpretation or, alternately, the reaction of the sixth-grade teachers if the input level is not considered. This is what people fear about a formal information system that apparently lacks feeling and judgment and that progressively loses data context as it carries the information to higher and higher (management) levels. This is a

feeling that you, as managers, must allay if you do not want your newly acquired information system to polarize your organization, set faction against faction, and lower productivity rather than strengthen the organization, making it more flexible and survivable.

It is not technical innovation but people's innovation that will strengthen your organization, and you must let the people participate and contribute in order to gain their acceptance.

EXECUTIVE INFORMATION SYSTEM	PERSISTENT PROBLEMS IN SYSTEMS DEVELOPMENT

SOME LESSONS TO DATE

TOP DOWN REPORTING CONTROL	ESSENTIAL
TOTAL TOP DOWN STRUCTURING	DISASTROUS
MINIMUM TOP DOWN STRUCTURING	BEST
SUBSTANTIAL BENEFITS TO DATA SUPPLIERS	ESSENTIAL
FLEXIBILITY AT ALL LEVELS	ESSENTIAL

In summary, although my main accomplishments are in the technical domain of information systems, the message I want to leave with you is that technical problems won't limit your information system; you will be more limited by your style and management ability.

Useful lessons that I have learned from my experiences as a manager of or consultant in the acquisition of formal information systems are summarized below.

Top-down reporting control is essential; without it, data cannot be communicated meaningfully. However, top-down structuring of the total presupposes a knowledge of such factors as need and cost. Such knowledge just isn't available at any top that I have observed. Even within my own Division at Mitre, many suggestions for improvements to the information system originate quite a way down.

To get the maximum participation of and provide the most usefulness to the lower levels of the organization, the top should do the minimum structuring consistent with its own needs and goals. And this leads me to my key requirement: those below you in the information chain must feel and derive benefits from "doing their thing" as participants in system design, development, and use.

The last lesson is mostly motherhood, but in these days of change and crisis a viable organization must be able to change its form and change its lines of communication in order to adapt. This requires a flexibility that is hard to achieve but sweet to contemplate while proceeding with the formulation of a new or improved information system to assist in managing and conducting the business of the organization.

OPERATION PEP

a state-wide project to prepare educational planners for California